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[Title of the Invention] METHOD FOR ASSEMBLING LIQUID
CRYSTAL SUBSTRATE

[Abstract]

[Object] There is provided a method for assembling liquid crystal substrate in which the supplied quantities of the liquid crystal agents are maintained accurate, the dispersion time of the liquid crystal agents is made short, and the liquid crystal substrates are bonded in short time, thereby making it possible to enhance the productivity of the liquid crystal substrate.

[Solving Means] A method for assembling liquid crystal substrate is disclosed wherein one of the substrates being bonded is held at a rear surface of the pressing plate, the other of the substrates is held on a table, thereafter both of the substrates are placed to opposes each other, and wherein after supplying a liquid crystal agent on the substrate held on the table, both of the substrates are bonded each other while narrowing the distance therebetween by means of the adhesive agent provided on either one of the substrates. The method is characterized in that: the liquid crystal agent supplied on the one of the substrate that is held on the table and the substrate held at the rear surface of the pressing plate are made contacted to each other, and the liquid crystal agent is in this state dispersed in a

direction where the main surface of the substrate is dispersed by moving either one of the substrates and thereafter the substrates are bonded each other.

[Claims]

[Claim 1] A method for assembling liquid crystal substrate wherein one of the substrates being bonded is held at a rear surface of the pressing plate, the other of the substrates is held on a table, thereafter both of the substrates are placed to opposes each other, and wherein after supplying a liquid crystal agent on the substrate held on the table, both of the substrates are bonded each other while narrowing the distance therebetween by means of the adhesive agent provided on either one of the substrates, the method characterized in that:

said liquid crystal agent supplied on said one of the substrates that is held on said table and said substrate held at the rear surface of said pressing plate are made contacted to each other, and said liquid crystal agent is in this state dispersed in a direction where the main surface of said substrate is dispersed by moving either one of said substrates and thereafter said substrates are bonded each other.

[Claim 2] The method for assembling liquid crystal substrate according to Claim 1, wherein said moving one of

the substrate is being moved in a direction where the main surface of the substrate is dispersed.

[Claim 3] The method for assembling liquid crystal substrate according to Claim 1, wherein in a state where the adhesive agents provided on one of the substrates are not contacted to the other one of the substrate, by making said substrate held at the rear surface of said pressing plate to be contact with said liquid crystal agents supplied on said the other of the substrates that is held on the table, thereby dispersing said liquid crystal agents in a direction where the main surface of the substrate is dispersed.

[Claim 4] The method for assembling liquid crystal substrate according to Claim 1, wherein in a state where said adhesive agents are provided on either one of the substrates such that they have closed patterns thereon, said liquid crystal agents are supplied into said closed patterns with an amount that is thicker than that of said adhesive agents, and the distance between both substrates are narrowed such that both substrates are bonded each other by said adhesive agents.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a method for

assembling liquid crystal substrates where each of the substrates to be bonded is held to oppose each other and the substrates are bonded by narrowing the distance therebetween.

[0002]

[Description of the Related Art]

In producing a liquid crystal display panel, a process is known where two pieces of glass substrate having transparent electrodes or thin transistor arrays attached thereon are bonded by means of adhesive agents (hereinafter will be referred to seal agents) with a very narrow distance therebetween for example about several microns, and thereby sealing the liquid crystal agents on the area formed accordingly.

[0003]

As a method for sealing the liquid crystal agents, the method which is disclosed in a Japanese Unexamined Patent Publication No. S62-165622 has been proposed. In this method, the sealing agents are drawn in closed patterns such that an injection hole needs not be provided in one of the substrates. Further, in a state where the liquid crystal agents are dropped into the closed patterns, the other one of the substrates are placed on the one of the substrates and thereafter the upper and lower substrates are put closer to each other in a vacuum atmosphere whereby bonding the upper and lower substrates.

[0004]

[Problems to be Solved by the Invention]

However, in the conventional method, because the amount of the liquid crystal agents that are supplied into the closed patterns after sealing process increases more than the application amount that was originally required, the liquid crystal agents in some occasions may be over-flown outside of the seal agent. In this case, it may be required to wash the substrates, which will make the high cost liquid crystal agents useless.

[0005]

As a means for supplying a required amount of agents with accuracy, a plunger is commonly used. Because the plunger drops one droplet at a time that is called a droplet number, however, it may require from several minutes to tens of minutes before the liquid crystal agents are dispersed far into the inner side of the patterns.

[0006]

In order to shorten the dispersion time by using a lesser amount of one droplet and narrowing the dispersion regions of the liquid crystal agents, it is required to maintain the required supply amount as a whole by increasing the droplet number. In addition, because the application amount at one droplet number is less in this case, the application amount is likely to be uneven such that the

supply time of the liquid crystal agents is increased by the increased amount of the droplet number.

[0007]

In other words, it is required that the supplied quantities of the liquid crystal agents are maintained accurate and thereby omitting the washing process so that the useless supply of the liquid crystal is prevented, but also required that the dispersion time of the liquid crystal agents is made short and the liquid crystal substrates are bonded in short time thereby making it possible to enhance the productivity of the liquid crystal substrate. However, both of the requirements could not be accomplished in the conventional methods.

[0008]

Therefore, the object of the present invention is to provide a method for assembling liquid crystal substrate in which the supplied quantities of the liquid crystal agents are maintained accurate, the dispersion time of the liquid crystal agents is made short, and the liquid crystal substrates are bonded in short time, thereby making it possible to enhance the productivity of the liquid crystal substrate.

[0009]

[Means for Solving the Problems]

In order to accomplish the above-mentioned objects, the

present invention provides a method for assembling liquid crystal substrate wherein one of the substrates being bonded is held at a rear surface of the pressing plate, the other of the substrates is held on a table, thereafter both of the substrates are placed to opposes each other, and wherein after supplying a liquid crystal agent on the substrate held on the table, both of the substrates are bonded each other while narrowing the distance therebetween by means of the adhesive agent provided on either one of the substrates. The method is characterized in that the liquid crystal agent supplied on the one of the substrate that is held on the table and the substrate held at the rear surface of the pressing plate are made contacted to each other, and the liquid crystal agent is in this state dispersed in a direction where the main surface of the substrate is dispersed by moving either one of the substrates and thereafter the substrates are bonded each other.

[0010]

[Embodiments]

Hereinafter, an embodiment of the present invention will be further described with reference to the attached drawings.

[0011]

In Fig. 1, the substrate assembly apparatus which embodies the present invention is comprised of a liquid

crystal dropping part S1 and a substrate bonding part, which are disposed adjacent to each other on the claw plate 2.

[0012]

A frame 3 that supports the substrate bonding part S2 is disposed on the upper side of the claw plate 2. Moreover, a X, Y, theta stage T1 is provided on the upper surface of the claw plate 2. The X stage 4a constituting the X, Y, theta stage T1 is configured to be movable in X axis that corresponds to a horizontal direction in drawing by means of a driving motor 5. That is, the X stage 4a moves between the liquid crystal dropping part S1 and the substrate bonding part S2. The Y stage 4b is located on the X stage 4a and is configured to be movable in Y axis that crosses X axis by means of the driving motor 5. The theta stage 4c is located on the Y stage 4b and is configured to be rotatable through a rotating bearing 7 in a plane with respect to the Y stage 4b. A table 9 having a lower substrate 1a mounted thereon is fixed on the theta stage 4c. In addition, like the upper substrate that will be described later, the lower substrate 1a is mounted and held on the table 9 by means of a vacuum absorption method or an electrostatic absorption method. Moreover, a lower chamber unit 10 is fixed on the Y stage 4b by means of a plate 13. The theta stage 4c is attached to the lower chamber unit 10 through the vacuum seal 12 such that the theta stage 4c can freely rotate with

respect to the lower chamber unit 10 by means of the rotating bearing 11. The theta stage 4c has a structure that the lower chamber unit 10 does not rotate itself even when the theta stage 4c is rotating.

[0013]

The liquid crystal dropping part S1 is comprised of a dispenser 17 for dropping a desired amount of liquid crystal agents on the lower substrate 1a that is mounted and held on the table 9, a Z axis stage 15 which moves the dispenser 17 vertically, and a driving motor 16 which drives the Z axis stage 15. Here, the dispenser 17 is supported by a bracket 14 that is projected from the frame 3. The X, Y, theta stage T1 having the lower substrate 1a mounted and held on the table 9, moves X and Y directions with respect to the nozzle 18 of the dispenser 17 which drops the liquid crystal agents. With this construction, a desired amount of liquid crystal agents are dropped at an arbitrary position on the lower substrate 1a.

[0014]

The X, Y, theta stage T1 which is mounting and holding the lower substrate 1a where the liquid crystal agents are dropped, moves down to the substrate bonding part S2 by the driving motor 5.

[0015]

In the substrate bonding part S2, the upper chamber

unit 21 and the press plate 27 are configured to be able to move up and down independently and respectively. Here, the press plate 27 has a vacuum absorption function and an electrostatic absorption function. In other words, the upper chamber unit 21 has a housing that contains a linear bush and a vacuum seal. In addition, the upper chamber unit 21 is able to move up and down in Z axis direction by the cylinder 22 fixed on the frame 3 and guided by a shaft 29.

[0016]

As the X, Y, theta stage T1 is moved to the substrate bonding part S2 and the upper chamber unit 21 is lowered, the flange 21a of the upper chamber unit 21 come in contact with an O ring 44 disposed around the lower chamber unit 10 such that they become one body. At this time, they serve as a vacuum chamber. Here, the ball bearing 87 provided around the lower chamber unit 10 serve as adjusting the crush amount of the O ring 44 by the vacuum and is configured to be located at an arbitrary position in a vertical direction. Since the huge force generated from the vacuum is received by the lower chamber unit 10 through the ball bearing 87, the O ring 44 may be deformed by the elasticity. Thus, it is possible to determine the position of the X, Y, theta stage T1 within the elasticity range of the O ring 44 with easiness and precision by moving the X, Y, theta stage T1 gently during bonding process, which will be described later.

[0017]

Even when the vacuum chamber formed by the upper chamber unit 21 and the lower chamber unit 10 is deformed, because housing 30 contains a vacuum seal which does not leaks the vacuum with respect to the shaft 29 and is vertically movable, it is possible to prevent the press plate 27 fixed on the shaft 29 from deforming and is possible to bond the upper substrate 1b held on the press plate 27 and the lower substrate 1a held on the table 9 with maintaining both substrates in parallel.

[0018]

In drawing, the reference number 23 denotes a vacuum valve and the reference number 24 denotes a pipeline hose. The pipeline hose 24 is connected a vacuum source. The vacuum valve 23 and the pipeline hose 24 are used to decrease the pressure of the vacuum chamber to a vacuum state. In addition, the reference number 25 denotes a gas purge valve and the reference number 26 denotes a gas tuner. The gas tuner 26 is connected to a pressure source such as N₂ or clean dry air and the like. The gas purge valve 25 and the gas tuner 26 are used to restore the vacuum chamber to an atmospheric pressure.

[0019]

The upper substrate 1b is fixed and held on the lower surface of the press plate 27 but it is configured to be

held by means of the vacuum absorption under an atmospheric environment. Here, the reference number 41 denotes an absorption joint and the reference number 42 denotes a plurality of absorption tubes. The absorption tubes 42 are connected to a vacuum source and at the surface of the press plate 27, a plurality of absorption holes connected thereto are provided.

[0020]

Now, a description will be made to the electrostatic absorption means.

[0021]

The press plate 27 has two square shaped hollow parts at its bottom surface. Each of the hollow parts contains a parallel plate electrode that is covered with an insulator. The main surface of the insulator is in the same plane as the bottom surface of the press plate 27. The buried parallel electrodes are respectively connected to the positive and negative direct current source via a suitable switch mechanism. Therefore, when a positive or negative voltage is applied to each of the parallel plates, negative or positive charges are induced at the main surface of the insulator that is in the same plane as the bottom surface of the press plate 27. With these charges, a coulombs' force is generated between the transparent electrode films of the upper substrate 1b and the upper substrate 1b is electro-

statically absorbed by the coulombs' force. The voltage applied to each of the parallel electrodes may have same or different polarities. Moreover, in atmospheric environment, the vacuum absorption may be used in combination to the electrostatic absorption. Also, when the electrostatic absorption force is prevailing, the vacuum absorption means may not be required.

[0022]

By the way, the shaft 29 is fixed to the housing 31 and 32. The housing 31 is attached with respect to the frame 30 by means of the linear guide 34. The press plate 27 is configured to be movable in vertical directions. Here, the vertical movement is accomplished by means of motor 40 that is fixed to the bracket 38 on the frame 35 connected by the frame 3. The transmission of the movement is accomplished by means of ball screw 36 and nut housing 37. The nut housing 37 is connected to the housing 32 through the load measuring unit 33 and operates integrally with the press plate 27 at the lower side of that.

[0023]

Therefore, as the shaft 29 is lowered by the motor 40, the press plate 27 that contains the upper substrate 1b is lowered. Then, the upper substrate 1b is attached to the lower substrate 1a on the table 9 such that it is constructed to make it possible to provide the press

pressure necessary to the bonding thereof. In this case, the load measuring unit 33 serves as a pressure sensor and controls the motor 40 based on the feedback signals such that it is made possible to provide a desired pressure to the upper and lower substrate 1a and 1b.

[0024]

Since the lower substrate 1a is mounted in a gravity direction, as shown in Fig. 2, the position of the lower substrate 1a is easily determined by pressing the position determination member 81 in a horizontal direction by means of a press roller 82.

[0025]

However, when determining a precise position thereof before the bonding process, it is likely that the upper substrate 1b rises or it is misaligned with the lower substrate 1a from the influence where the upper substrate 1b is made to be contact with the seal agent on the lower substrate 1a or the liquid crystal agents. Otherwise, it is likely that the upper substrate 1b is misaligned with the lower substrate 1a from the influence where the air inhaled in between the lower substrate 1a and the upper substrate 1b is leaked in the process of depressing the vacuum chamber. Therefore, the electrostatic absorption function is also provided to the table 9. Moreover, by providing the table 9 with a pin that is movable in Z axis directions and making

the pin being grounded, it is possible to prevent the bonded substrates from being charged and to facilitate the separation from the table 9.

[0026]

In Fig. 2, reference number 60 denotes a catch claw that is located in two of the diagonal positions of the upper substrate 1b and is suspended by the shaft 59 elongated downward. The catch claw is configured to catch the upper substrate 1b at a position slightly below the press plate 27 when the upper substrate 1b is falling because the vacuum absorption force is scarce as a result from that the press plate 27 performs a vacuum absorption and the vacuum chamber is depressed. Though not specifically depicted in drawing, the shaft 59 is configured to be movable in vertical directions and be rotatable because it is vacuum-sealed through the upper chamber unit 21. In addition, the shaft 59 is configured to be able to move vertically independent from the vertical movement of the press plate 27, but also to be rotated by means of the rotational actuator, such that the catch claw 60 disperses the liquid crystal in a direction where the main surface of the substrates 1a and 1b is dispersed, or retract the liquid crystal in a way that the bonding process is not hindered in future.

[0027]

Next, a description will be given to the method for assembling the substrates by using the substrate assembly apparatus described above.

[0028]

First, a jig holding the upper substrate 1b is mounted on the table 9 and the X, Y, theta stage T1 is moved to the substrate bonding part S2 by using the driving motor 5. Then, the press plate 27 is lowered through the shaft 29 by using the motor 40, the upper substrate 1b on the table 9 is vacuum-absorbed and thereafter is raised by the motor 40 such that the upper substrate 1b is revealed in atmosphere environment.

[0029]

Then, the X, Y, theta stage T1 is returned to the liquid crystal dropping part S1, and the empty jig is removed. After that, the lower substrate 1a is mounted on the table 9 such that it is held and fixed at a desired position as shown in Fig. 2.

[0030]

Though not shown in Fig. 1, because a dispenser that discharges the seal agents are disposed at the frame 3 that is near the dispenser 17 which discharges and loads the liquid crystal agents, the dispenser discharges the seal agents as the lower substrate 1a is moved in XY axis directions by each motor 5 and 6 of the X, Y, theta stage T1,

such that the seal agents are drawn in closed patterns on the lower substrate 1a.

[0031]

Thereafter, the liquid crystal agents are loaded from the dispenser 17 to the lower substrate 1a.

[0032]

Following this, the X, Y, theta stage T1 is moved to the substrate bonding part S2 at a height where the bottom surface of the upper substrate 1b holding the press plate 27 is made to be contact to the liquid crystal agent on the lower substrate 1a.

[0033]

The liquid crystal agent is expanded by the surface tension at about several millimeter height. In contrast, the seal agents are at about 20 micron. Therefore, the upper surface 1b does not contact with the seal agents and thus is sufficiently able to contact with the liquid crystal agents.

[0034]

Next, with a reference to Fig. 3, a description will be made to the process for dispersing the liquid crystal agents in a direction where the main surface of the lower substrate 1a is dispersed.

[0035]

The left side of Fig. 3 shows the positional relation

of both substrates 1a and 1b and the right side of Fig. 3 is an enlarged plan view of one location of the liquid crystal agents (P) on the lower substrate, where a solid line shows the present state and a dotted line shows the previous state.

[0036]

The left side of Fig. 3a shows a state where the liquid crystal agents (P) are applied on the lower substrate 1a. At this state, one location of the liquid crystal agents will be denoted by P1.

[0037]

The upper substrate 1b is lowered and is made to contact with the liquid crystal agent (P) at its bottom surface. By further lowering the upper substrate 1b, the liquid crystal agents is pressed and dispersed like P2 as shown in right side of Fig. 3b.

[0038]

In a state where the upper substrate 1b is contacted with the liquid crystal agents, the X, Y, theta stage T1 is moved from initial contact position to X axis + direction, X axis - direction, the initial contact position, Y axis + direction, Y axis - direction, respectively, as shown in Figs. 3c to 3g.

[0039]

When the X, Y, theta stage T1 is moved for example to X axis + direction, the liquid crystal agents is dispersed in

X axis + direction as indicated by P3, due to the adhesion to the upper substrate 1b.

[0040]

Likely, in Fig. 3d and after, when the lower substrate 1a is moved to each of X and Y directions with respect to the upper substrate 1b by the X, Y, theta stage T1, the liquid crystal agents is dispersed in a rectangular shape having a line corresponding to the traveling distance of the X, Y, theta stage T1, as indicated by P4 to P6. As the liquid crystal agents is dispersed, the thickness thereof becomes thinner and thus the press plate 27 is smoothly lowered. But the bottom surface of the upper substrate 1b does not contact with the seal agents provided on the lower substrate 1a. In other words, the application height of the seal agents, the application height of the liquid crystal agents, the distance between corresponding plane of both upper and lower substrates 1a and 1b can be known from the data that are inputted to the device. Further, because the upper and lower substrates are vacuum-absorbed in parallel, while the press plate 27 is lowered by the motor 40 to the extent that the bottom surface of the upper substrate 1b does not contact with the seal agents and thereafter the upper and lower substrates are moved respectively to X and Y direction, the traveling distance of the press plate is managed such that it does not destroy the shape of the seal

agents.

[0041]

In this way, the liquid crystal agents are sufficiently dispersed into the seal agents' pattern and the bonding process is performed thereafter.

[0042]

Then, the upper chamber unit 21 is lowered by the cylinder 22 and the flange part 21a is abutted to the O ring 44 such that the upper chamber unit 21 forms a vacuum chamber with the lower chamber unit 10. Thereafter, the vacuum chamber is depressed by releasing the vacuum valve 23. At this instance, because the upper substrate 1b is vacuum-absorbed to the press plate 27, as the depressing goes on, the vacuum absorption force with respect to the upper substrate 1b becomes weaker and as a consequence the upper substrate 1b falls by it's weight. The falling upper substrate 1b is received by the catch claw 60 as shown in Fig. 2, and is held slightly below the press plate 27.

[0043]

At time when the vacuum chamber is sufficiently made vacuum state, a voltage is applied to the electrostatic absorption means of the press plate 27 such that the upper substrate 1b on the catch claw 60 is held on the press plate 27 by the coulombs' force. In this case, because the vacuum chamber is already in a vacuum state, the air is not

resident between the press plate 27 and the upper substrate 1b, and in turn the upper substrate 1b do not floating when the air is leaked.

[0044]

Thereafter, the shaft 59 is lowered by means of elevating actuator not shown in drawing and then is rotated by means of rotating actuator. After making sure that the catch claw 60 does not disturb the bonding process of the upper and lower substrate, the press plate 27 is further lowered by using motor 40 and the bottom surface of the upper substrate 1b is contacted with the aid of the seal agents on the lower substrate 1a. And then, while measuring the applied pressure on the seal agents by means of the load measuring unit 33, the motor 40 is controlled to bond the upper and lower substrates 1a and 1b at desired distance therebetween.

[0045]

In this case, because the upper substrate 1b is attached to the press plate 27 and the central part of the upper substrate 1b does not sag, it does not have bad influence to the spacer in the liquid crystal agents or does not deteriorate the alignment of both substrates. Further, the alignment is accomplished by reading out a alignment mark provided to the upper and lower substrates 1a and 1b by using image recognition camera from a peep provided on the

upper chamber unit 21 and calculating the position of the readout alignment mark by means of image processing, and performing the high precision alignment while gently moving each stage 4a to 4c of the X, Y, theta stage T1. When moving the stages, the ball bearing 87 maintains the distance between the upper and lower chamber unit 10 and 21 so that the O ring 44 does not excessively deform and maintain the vacuum state.

[0046]

Upon completion of the bonding process, the vacuum valve 23 is closed and the gas purge valve 5 is released. Then, the chamber is supplied with N₂ or clean dry air and returned to atmospheric pressure. Thereafter, the gas purge valve 25 is closed and the upper chamber unit 21 is raised by means of the cylinder 22. The X, Y, theta stage T1 is thereafter returned to the liquid crystal dropping part S1 and the bonded substrates are separated from the table 9 and prepared for the subsequent bonding process. After separated from the table 9, the seal agents on the substrates are cured by means of UV irradiation device or heating device at downstream side.

[0047]

In the embodiment described above, because the bonding process can be started right after the liquid crystals are dropped by discharging the seal agents, particles are not

likely to adhered to the substrate and it is thus possible to improve the yield of product. In addition, because the X, Y, theta stage T1 can be used in conveying the upper substrate 1b into the vacuum chamber, it is possible to facilitate the small sized devices. In particular, because the liquid crystal agents are dispersed with the substrates held at the X, Y, theta stage T1, it is possible to decrease the number of items supplied to one substrate and the deviation of the supply amount become smaller. Furthermore, the dispersion of liquid crystal agents is performed at each bonded substrate, the supplying process can proceed to the bonding process in a short time and the productivity thus is improved.

[0048]

Moreover, because the liquid crystal agents can be supplied with by an accurate amount, the liquid crystal agents are not likely to overflow outside the seal agents pattern to contaminate the substrate, and, at the same time, the wash process are not required, so that it is possible to reduce the useless consumption of the liquid crystal agents.

[0049]

The present invention is not limited to those embodiments described above, but may be practiced as follows:

[0050]

(1) The liquid crystal agents applied on the lower substrate 1b may be for example a linear shape and the like, other than the dot shape. In such case, the liquid crystal agents can be dispersed by merely relatively moving those substrates in elongated direction and vertical direction with respect to each other.

[0051]

(2) The direction of moving those substrates relative to each other in dispersing the liquid crystal agents, may be a circular direction or a spiral direction as long as the liquid crystal agents do not exceed the seal agents patterns.

[0052]

(3) The upper substrate 1b may be absorbed to the press plate 27 directly from the robot arm.

[0053]

[Effect of the Invention]

As described above, according to the method for assembling liquid crystal substrate of the present invention, the supplied quantities of the liquid crystal agents are maintained accurate, the dispersion time of the liquid crystal agents is made short, and the liquid crystal substrates are bonded in short time, thereby making it possible to enhance the productivity of the liquid crystal substrate.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is a schematic diagram illustrating a substrate assembly apparatus that is embodying an embodiment of the present invention.

[Fig. 2]

Fig. 2 is a perspective view illustrating a state where the upper and lower substrates are bonded each other.

[Fig. 3]

Fig. 3 is a diagram illustrating the process steps for dispersing the liquid crystal agent applied on the lower substrate by moving the upper substrate.

[Reference Numerals]

- 1a: lower substrate
- 1b: upper substrate
- 9: table
- 10: lower chamber unit
- 17: dispenser
- 21: upper chamber unit
- 23: vacuum valve
- 27: pressing plate
- T1: XYθ stage
- S1: liquid crystal dropping part
- S2: substrate bonding part

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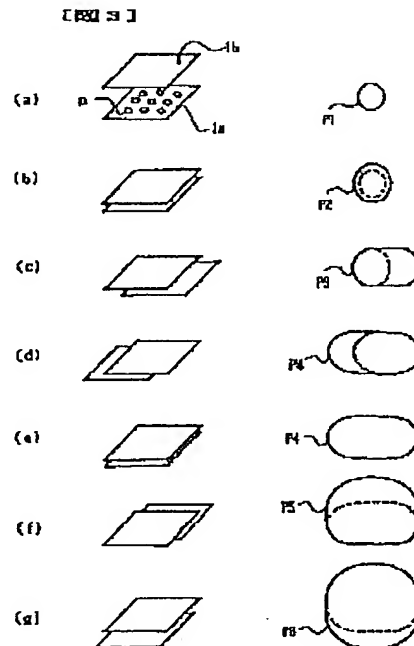
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(54)【発明の名称】 液晶基板の組立方法

(57)【要約】

【課題】 液晶剤の供給量を正確にする一方で、液晶剤の広がり時間を短くして液晶基板を短時間で貼り合わせ、生産性を向上することができる液晶基板の組立方法を提供することである。

【解決手段】 貼り合わせる一方の基板を加圧板の下面に保持し、貼り合わせる他方の基板をテーブル上に保持して対向させ、テーブル上に保持した基板に液晶剤を供給した後、両基板の間隔を狭めていずれかの基板に設けた接着剤により両基板を貼り合わせる液晶基板の組立方法であり、テーブル上に保持した他方の基板に供給した液晶剤を加圧板の下面に保持した基板を接触させ、いずれかの基板を移動させることにより液晶剤を基板の主面の広がり方向に拡張させ、その後に基板の貼り合わせを行なう。



【0012】架台2の上方には基板貼合部S2を支持するフレーム3がある。また、架台2の上面には、XYθステージT1が備えられている。XYθステージT1を

構成するXステージ4aは、駆動モータ5により、図面上で左右のX軸方向に、即ち、液晶滴下部S1と基板貼合部S2間を往来できるようになっている。Yステージ4bはXステージ4a上にあり、駆動モータ6によりXステージと直交するY軸方向に往来できるようになっている。θステージ4cはYステージ4b上にあり、回転ベアリング7を介して駆動モータ8によりYステージ4bに対して水平に回転可能になっていて、θステージ4c上に下基板1aを搭載するテーブル9が固定される。なお、後述する上基板と同様に、テーブル9は真空吸着や静電吸着で下基板1aを搭載保持をする。また、Yステージ4bにプレート13で下チャンバユニット10が固定されている。θステージ4cは、下チャンバユニット10に対し回転ベアリング11と真空シール12を介して回転自由に取付けられ、θステージ4cが回転しても下チャンバユニット10はつられて回転しない構造としている。

【0013】液晶滴下部S1は、テーブル9に搭載保持された下基板1aに所望量の液晶剤を滴下するためのフレーム3から突出したブラケット14で支持されたディスペンサ17とこれを上下移動させるためのZ軸ステージ15とそれを駆動するモータ16で構成される。下基板1aをテーブル9上に保持搭載したXYθステージT1は、液晶剤を滴下するディスペンサ17のノズル18に対し、XおよびY方向に移動する。これにより、下基板1a上の任意の個所に所望量の液晶剤が滴下される。

【0014】液晶滴下後の下基板1aを搭載保持したXYθステージT1は、基板貼合部S2の下部に駆動モータ5によって移動する。

【0015】基板貼合部S2では、上チャンバユニット21とその内部の真空吸着機能と静電吸着機能を備えた加圧板27がそれぞれ独立して上下動できる構造になっている。即ち、上チャンバユニット21は、リニアブッシュと真空シールを内蔵したハウジング30を有しており、シャフト29をガイドとしてフレーム3に固定されたシリンダ22により上下のZ軸方向に移動する。

【0016】XYθステージT1が基板貼合部S2に移動して上チャンバユニット21が下降すると、下チャンバユニット10の周りに配置してあるOリング44に上チャンバユニット21のフランジ21aが接触し一体となり、この時真空チャンバとして機能する状態になる。ここで、下チャンバユニット10の周囲に設置されたボールベアリング87は、真空によるOリング44のつぶれ量を調整するもので上下方向の任意の位置に設定可能となっている。真空化により発生する大きな力は、ボールベアリング87を介して下チャンバユニット10で受けており、Oリング44の弾性変形が可能で、後述するように貼り合わせ時にXYθステージT1をOリング44の弾性範囲内で容易に微動させ精密位置決することができる。

【0017】ハウジング30は、上チャンバユニット21が下チャンバユニット10と真空チャンバを形成して変形しても、シャフト29に対し真空漏れを起こさないで上下動可能な真空シールを内蔵しているので、真空チャンバの変形がシャフト29に与える力を吸収することができ、シャフト29に固定された加圧板27が変形することを防止でき、後述するように加圧板27に保持された上基板1bとテーブル9に保持された下基板1aとの平行を保って貼り合わせが可能となる。

10 【0018】23は真空バルブ、24は配管ホースで、図示していない真空源に接続され、これらは真空チャンバを減圧し真空にする時に使用される。また、25はガスバージバルブ、26はガスチューブで、N2やクリーンドライエアー等の圧力源に接続され、これらは真空チャンバを大気圧に戻す時に使用される。

【0019】上基板1bは加圧板27の下面に密着保持されるが、大気下においては真空吸着（あるいは吸引吸着）で保持されるようになっている。即ち、41は吸引吸着用継手、42は吸引チューブであり、図示していない真空源に接続され、加圧板27面には、それにつながる複数の吸引孔が設けられている。

【0020】次に、静電吸着手段について説明する。

【0021】加圧板27は下面に方形の凹部を2個有していて、各凹部に内蔵された平板電極を誘電体で覆ってその誘電体の主面が加圧板27の下面と同一平面になっている。埋め込まれた各平板電極はそれぞれ正負の直流電源に適宜なスイッチを介して接続されている。従って、各平板電極に正あるいは負の電圧が印加されると、加圧板27の下面と同一平面になっている誘電体の主面に負あるいは正の電荷が誘起され、それら電荷によって上基板1bの透明電極膜との間に発生するクーロン力で上基板1bが静電吸着される。各平板電極に印加する電圧は同極でもよいしそれぞれ異なる双極でもよい。尚、周囲が大気の場合、真空吸着を併用してもよいし、静電吸着力が大きい場合は、真空吸着手段を不要としてもよい。

【0022】さて、シャフト29はハウジング31、32に固定されている。ハウジング31はフレーム3に対してリニアガイド34で取付けられ、加圧板27は上下動可能な構造になっている。その上下駆動は、フレーム3とつながるフレーム35上のブラケット38に固定されたモータ40により行う。駆動の伝達は、ボールねじ36とナットハウジング37で実行される。ナットハウジング37は荷重計33を介してハウジング32とつながり、その下部の加圧板27と一体で動作する。

【0023】従って、モータ40によってシャフト29が下降し、上基板1bを保持した加圧板27が下降し、上基板1bがテーブル9上の下基板1aと密着して、貼り合わせに必要な加圧力を与えることのできる構造となっている。この場合、荷重計33は加圧力センサとして

働き、逐次、フィードバックされた信号を基にモータ40を制御することで、上下基板1a、1bに所望の加圧力を与えることが可能となっている。

【0024】下基板1aは重力方向の搭載なので、図2に示すようにテーブル9に設けた位置決め部材81に押付ローラ82による水平方向での押付けによる位置決めの固定で十分である。

【0025】しかしながら、貼り合わす直前の微小位置決めの際、上基板1bが下基板1a上のシール剤や液晶剤と接触した影響で下基板1aがずれたり持上る可能性があることや、真空チャンバ内が減圧され真空になる過程で下基板1aとテーブル9との間に入り込んでいる空気が逃げて下基板1aが踊りずれる可能性があるもので、テーブル9に対しても静電吸着の機能を持たせている。そして、テーブル9に上下2軸方向に移動できるピンを設け接地しておく、貼り合わせ後の基板の帯電防止とテーブル9からの取り外しを容易に行なうことができる。

【0026】図2に示す60は、加圧板27が真空吸着をしていて真空チャンバが減圧され真空吸着力が消えて上基板1bが落下するときに加圧板27の僅か下の位置で受け止める受止爪で、上基板1bの2個の対角の位置にあって下方に伸びたシャフト59で釣り下げた形に支持されている。具体的には図示していないが、シャフト59は上チャンバユニット21介して真空シールされて回転と上下移動ができるようになっている。また、シャフト59は、加圧板27の上下移動と独立して上下に移動できるだけでなく、回転アクチュエータによって回転させて、受止爪60が液晶を両基板1a、1bの主面の広がり方向に拡張させたり、その後に基板の貼り合わせを行なう場合の邪魔にならぬように退避させることができるようになっている。

【0027】次に、本基板組立装置で基板を貼り合わせる工程について説明する。

【0028】まず、テーブル9に上基板1bを保持した治具を搭載し、駆動モータ5でXYθステージT1を基板貼合部S2に移動させる。そこでモータ40によりシャフト29を介して加圧板27を下降させ、テーブル9上の上基板1bを真空吸着させてから、モータ40で上昇させて、上基板1bを待機状態とする。

【0029】XYθステージT1は液晶滴下部S1に戻り、空になった治具が外され、テーブル9上に下基板1aが搭載され、図2に示すように所望位置に固定保持される。

【0030】図1には示していないが、液晶剤を吐出滴下するデイスペンサ17の近くのフレーム3にシール剤を吐出するデイスペンサがあって、XYθステージT1の各モータ5、6で下基板1aをXY軸方向に移動させつつシール剤を吐出させて、下基板1a上にクローズ（閉鎖）したパターンでシール剤を描画する。

【0031】その後、デイスペンサ17から液晶剤を下基板1a上に滴下する。

【0032】続いて、XYθステージT1を基板貼合部S2に移動させ、加圧板27に保持している上基板1bの下面が下基板1a上の液晶剤に接触する高さまで下降させる。

【0033】液晶剤は表面張力により数mm程度の高さに盛り上がっており、それに対して、シール剤の高さは20μm程度になっている。よって、上基板1bはシール剤に触れない高さで、十分に液晶剤に接触する。

【0034】以下、図3に示したモデルで液晶剤を下基板1aの主面の広がり方向に拡張させる工程について説明する。

【0035】図3の左側の図は両基板1a、1bの位置関係を示し、右側の図は下基板1a上の1箇所の液晶剤Pの広がり状況を平面的に表すもので、実線が現状での広がり、また点線がその1工程前での広がり状況を示している。

【0036】図3(a)の左側では、下基板1a上に複数箇所に液晶剤Pを塗布供給した状況を示している。この時点での1箇所の液晶剤をP1とする。

【0037】上基板1bを下降させその下面が液晶剤Pに接触した後、さらに上基板1bを下降させると、図3(b)の右側のように液晶剤はP2のように押しつぶされて広がる（拡張する）。

【0038】上基板1bが液晶剤に接触した状態のまま、XYθステージT1を最初の接触位置を中心として、図3(c)乃至図3(g)に示すようにX軸+方向、X軸-方向、最初の接触位置、Y軸+方向、Y軸-方向にそれぞれ移動させる。

【0039】その移動の際、例えば、XYθステージT1がX軸+方向に移動する場合、液晶剤は上基板1bとの粘着でP3で示すようにX軸+方向に広がる。

【0040】図3(d)以降のように、下基板1aがXYθステージT1で上基板1bに対しXY各軸方向に移動することで液晶剤はP4からP6で示すように、XYθステージT1の移動距離の直径を持ったほぼ四角形の形状に広がる。液晶剤を広げると厚さは薄くなって行くから、加圧板27は徐々に下降させていくが、上基板1bの下面は下基板1aに設けているシール剤に接触しないようにしている。すなわち、シール剤の塗布高さ、液晶剤の塗布高さ、上下各基板1a、1bの対向面間距離は装置が予め入力してあるデータで分っており、かつ、上下各基板は真空吸着されて平行になっているので、モータ40で加圧板27を上基板1bの下面がシール剤に接触しない位置まで下降させ、次いで上下基板をXY各方向に相対移動させている間は、シール剤の形をくずさないよう（接触しないように）加圧板の移動距離の管理を行なう。

【0041】かくして、液晶をシール剤のパターンの内

側に十分に行き渡らせた後、基板の貼り合せを行う。

【0042】即ち、シリンダ22で上チャンバユニット21を下降させ、そのフランジ部21aをリング44に当接させて下チャンバユニット10と真空チャンバを形成させる。そして、真空バルブ23を開放して真空チャンバ内を減圧していく。この時、上基板1bは加圧板27に真空吸着された状態になっているので、減圧が進み真空化していくと上基板1bに作用していた真空吸着力は消えて行き、上基板1bが自重で落下する。これを図2に示すように受止爪60で受け止めて、加圧板27の僅か下の位置に保持しておく。

【0043】真空チャンバ内が充分真空になった時点で、加圧板27の静電吸着手段に電圧を印加して受止爪60上の上基板1bを加圧板27にクーロン力で保持する。この場合、既に真空になっているので、加圧板27と上基板1bの間に空気が残るようなことは無いし、その空気が逃げるときに上基板1bが踊ることもない。

【0044】その後、図示を省略した昇降アクチュエータでシャフト59を下降させ、次に、回転アクチュエータでシャフト59を回転させ、受止爪60が上下両基板の貼り合わせの邪魔にならぬようにしてから、モータ40で加圧板27をさらに下降させ、上基板1bの下面を下基板1a上のシール剤に接触させ、荷重計33でシール剤に付加する加圧力を計測しつつモータ40を制御して上下両基板1a、1bを所望間隔に貼り合わせる。

【0045】この場合、上基板1bは加圧板27に密着していて中央部が垂れ下がっていることはないから、液晶剤中のスペーサに悪影響を与えたり、基板同士の位置合わせが不良になることはない。因みに、位置合わせは図示を省略した上チャンバユニット21に設けた覗き窓から画像認識カメラで上下各基板1a、1bに設けられている位置合わせマークを読み取って画像処理により位置を計測し、XYθステージT1の各ステージ4a乃至4cを微動させて、高精度な位置合わせを行なう。この微動において、リング44が極端に変形しないで真空が維持されるように、ボールベアリング87が上下チャンバユニット10、21の間隔を維持している。

【0046】貼り合わせが終了すると、真空バルブ23を締めてガスパーズバルブ25を開き、真空チャンバ内にN2やクリーンドライエアーを供給し、大気圧に戻してからガスパーズバルブ25を閉じて、シリンダ22で上チャンバユニット21を上昇させ、XYθステージT1を液晶滴下部S1に戻して、テーブル9から貼り合せた基板を外し、次の貼り合わせに備える。テーブル9から外した後、基板は下流のUV光照射装置や加熱装置などでシール剤が硬化される。

【0047】以上の実施形態では、シール剤を吐出して液晶を滴下した後直ちに貼り合せに移行することができるので、基板が塵埃を受けづらく生産歩留まりを向上で

きる。また、XYθステージT1を上基板1bの真空チャンバ内への搬送に利用でき、装置の小型化が図られている。特に、XYθステージT1の移動で基板を保持したまま液晶剤を広げるので1基板への供給点数を減らすことができ供給量のばらつきは小さくなり、しかも、液晶剤の拡張を貼り合わせる基板同士で行うので、短時間で供給から貼り合わせに進むことができ、生産性は向上する。

【0048】また、液晶剤は正確な量を供給することができるため、液晶剤がシール剤パターンの外側にあふれて基板を汚染するおそれがなく、かつ、洗浄工程は不要となって液晶剤の無駄な消費を無くすることができる。

【0049】本発明は以上説明した実施形態に限らず、以下の様に実施しても良い。

【0050】(1) 下基板1bに塗布される液晶剤が点状以外の形状、たとえば線状などであってもよい。この場合、線の伸延方向と垂直な方向に基板同士を相対的に移動させるだけで、液晶剤を広げることができる。

【0051】(2) 液晶剤を拡張させる基板同士の相対的移動方向は、液晶剤がシール剤のパターンを超えない範囲であれば、円形や渦巻き型など、どのようなものであってもよい。

【0052】(3) 上基板1bはロボットハンドから直接加圧板27に吸引吸着させてよい。

【0053】

【発明の効果】以上説明したように、本発明によれば、液晶剤の供給量を正確にする一方で、液晶の広がり時間を短くして液晶基板を短時間で貼り合わせ、生産性を向上することができる。

【図面の簡単な説明】

【図1】本発明方法の一実施形態を具現化する基板組立装置の概略図である。

【図2】上下の各基板を貼り合わせる時の状況を示す斜視図である。

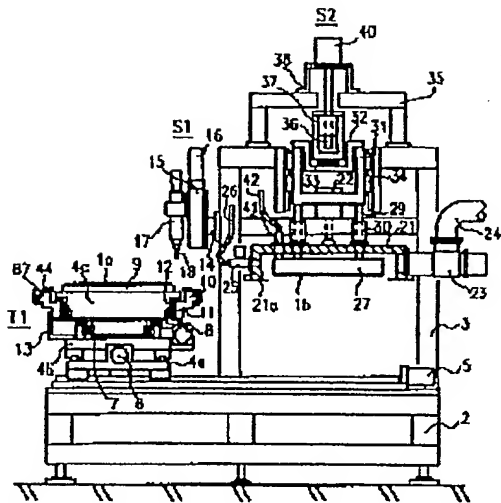
【図3】下基板に塗布した液晶剤を上基板により拡張させていく過程を示す図である。

【符号の説明】

1a 下基板
1b 上基板
9 テーブル
10 下チャンバユニット
17 デイスベンサ
21 上チャンバユニット
23 真空バルブ
27 加圧板
T1 XYθステージ
S1 液晶滴下部
S2 基板貼合部

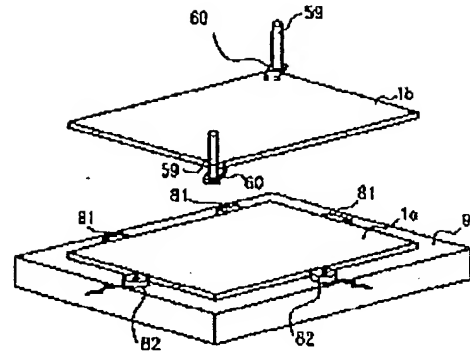
【図1】

【図1】



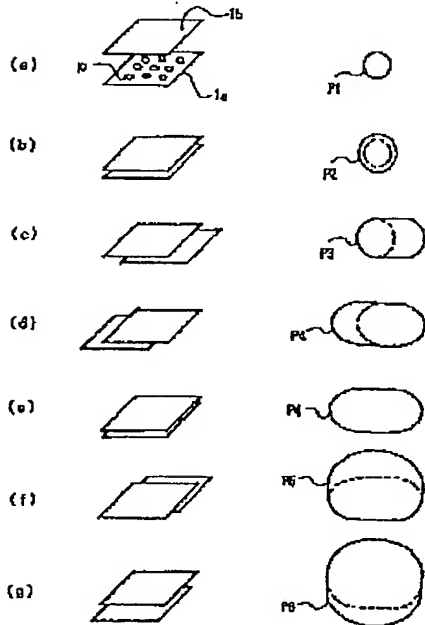
【図2】

【図2】



【図3】

【図3】



フロントページの続き

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